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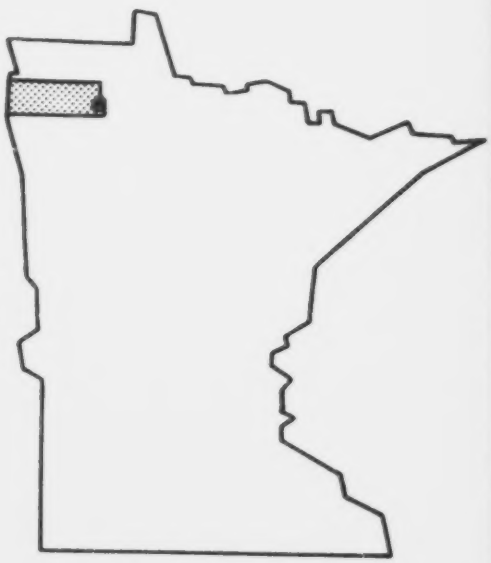
FLOOD INSURANCE STUDY



CITY OF GRYGLA, MINNESOTA
MARSHALL COUNTY

MARCH 30, 1982

Federal Emergency Management Agency

COMMUNITY NUMBER - 270269

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EXHIBITS

Flood Profiles

Mud River Panel 01P

Flood Boundary and Floodway Map

PUBLISHED SEPARATELY:

Flood Insurance Rate Map

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FLOOD INSURANCE STUDY

CITY OF GRYGLA

MARSHALL COUNTY, MINNESOTA

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the City of Grygla, Marshall County, Minnesota, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study will be used to convert the City of Grygla to the regular program of flood insurance by the Federal Emergency Management Agency (FEMA). Local and regional planners will also use this study in their efforts to promote sound flood plain management.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than those on which these Federally-supported studies are based. These criteria take precedence over the minimum Federal criteria for purposes of regulating development in the flood plain, as set forth in the Code of Federal Regulations at 44 CFR, 60.1(d). In such cases, however, it shall be understood that the state (or other jurisdictional agency) shall be able to explain these requirements and criteria.

1.2 Authority and Acknowledgements

The source of authority for this Flood Insurance Study is the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were performed by Edwards and Kelcey, Inc. for the Federal Emergency Management Agency, under contract No. EMW-C-0322. This study was completed in March 1981.

1.3 Coordination

Areas requiring detailed study were identified at a meeting held with representatives of the City, FEMA, the Minnesota Department of Natural Resources (Mn/DNR), and the study contractor in June 1979.

The peak flood discharges for the Mud River at Grygla were coordinated with the Mn/DNR, the U.S. Army Corps of Engineers (COE), the U.S. Geological Survey (USGS), the Soil Conservation Service (SCS), and the Minnesota Department of Transportation (Mn/DOT). Approval was received December 22, 1980 from the Interagency Hydrology Review Committee.

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Flood elevations, flood boundaries, and floodway delineations were coordinated with the community, Mn/DNR, and USGS.

On October 7, 1981 the results of the work by the Study Contractor were reviewed and accepted at a final coordination meeting attended by representatives of the Study Contractor, FEMA and the community.

2.0 AREA STUDIED

2.1 Scope of Study

The Flood Insurance Study covers the incorporated area of the City of Grygla, Marshall County, Minnesota. The area of study is shown on the Vicinity Map (Figure 1).

The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development or proposed construction for the next five years, through March 1986. The Mud River, within the corporate limits of Grygla, was studied by detailed methods.

2.2 Community Description

The City of Grygla is a rural community located in northwestern Minnesota in the eastern portion of Marshall County. The total land area within the corporate limits is approximately 0.25 square miles. The City of Grygla is completely surrounded by unincorporated areas of Marshall County. Grygla is approximately 75 miles northeast of East Grand Forks, Minnesota; 110 miles west of International Falls, Minnesota; and 30 miles northeast of Thief River Falls, Minnesota. Its population was 211 in 1970 (Reference 1).

The precipitation within the Mud River watershed is fairly uniform, the average being approximately 23 inches, with the average snowfall being approximately 34 inches. The mean temperature varies from 3 degrees Fahrenheit in January to 68 degrees Fahrenheit in July (Reference 2).

The Mud River starts 17 miles to the east of the City of Grygla, Minnesota, as a system of drainage ditches feeding into Judicial Ditch No. 11 which feeds into the Mud River. At Grygla, the drainage area of the Mud River is approximately 116 square miles.

The topography of Grygla is generally flat, sloping downward from east to west. Elevations range from 1165 to 1180 feet.

The primary land uses in the City of Grygla are residential development and agricultural cropland. The primary land use in the Mud River watershed is agricultural cropland.

State Highway 89 runs east to west through the city and then north-south on eastern edge. County Highway 54 runs north-south along the eastern edge of the city.

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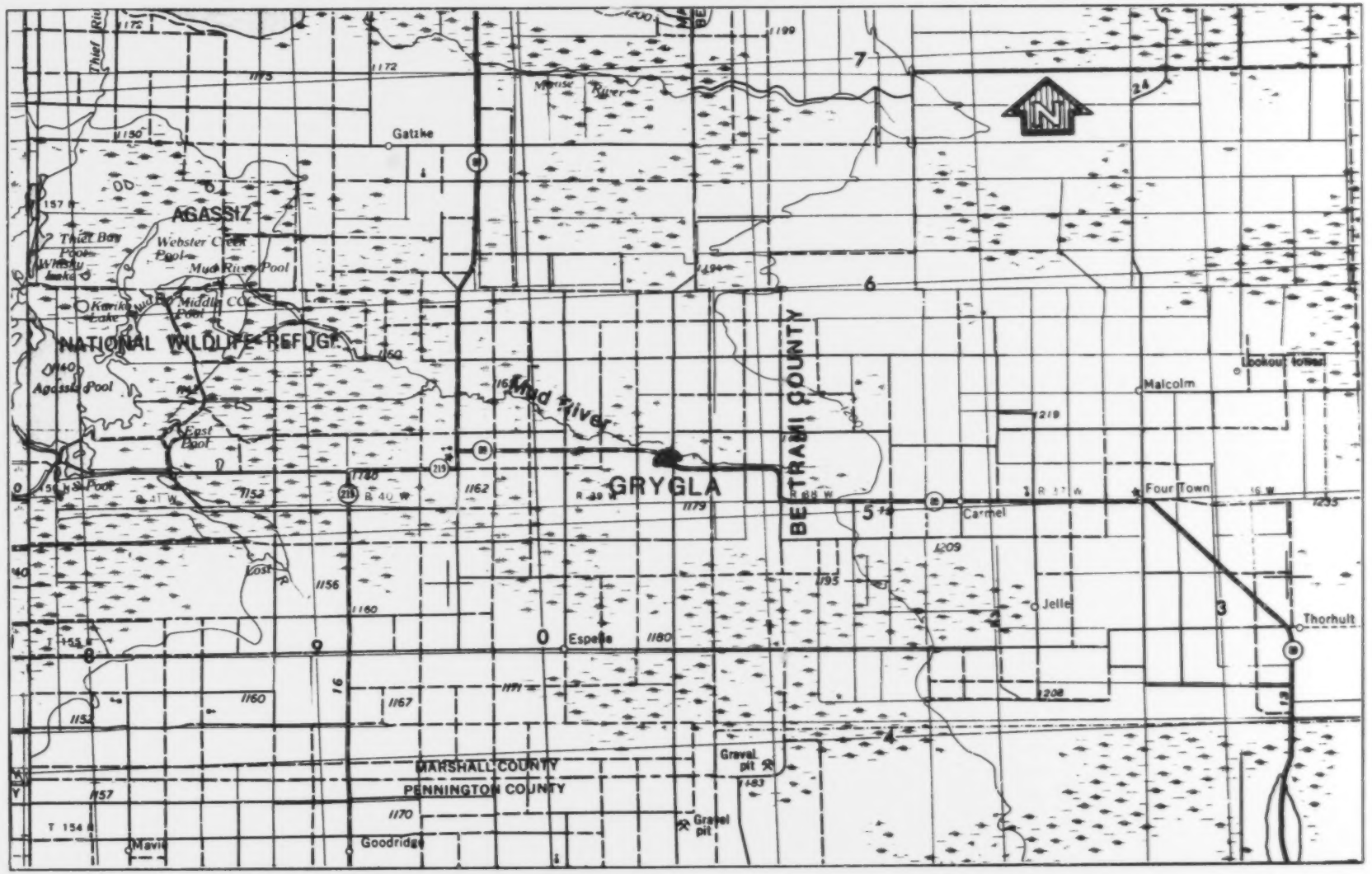

FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF GRYGLA, MN
(MARSHALL CO.)

APPROXIMATE SCALE

4 0 4 8 12 MILES

VICINITY MAP

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The majority of development within the flood plain is commercial with only minor residential development. Most of the residential and commercial development within the City of Grygla has occurred on the south side of the river and west side of State Highway 89.

2.3 Principal Flood Problems

The most severe flooding in Grygla occurs as a result of summer storm precipitation. The flood of record for Grygla occurred in July 1919 following 19 inches of rain; recent flooding occurred in the springs of 1978 and 1979 but no record of discharges exists. Past flooding problems have occurred due to water backing up to the east of the State Highway 89 bridge over Mud River. (Figures 2 - 5 illustrate flooding during the spring of 1978 within the city).

2.4 Flood Protection Measures

There are no flood control structures in the city.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equalled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence intervals), have been selected as having special significance for flood plain management and for flood insurance premium rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1 and 0.2 percent chance, respectively, of being equalled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than one year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (one percent chance of annual occurrence) in any 50-year period is about 40 percent (four in ten), and for any 90-year period, the risk increases to about 60 percent (six in ten). The analyses reported here reflect flooding potentials based on conditions existing in the community at the time of completion of this study.

Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for floods of the selected recurrence intervals for each flooding source studied in detail affecting the community.

A discharge-frequency relationship for the Mud River at Grygla was prepared utilizing the relationship outlined in Techniques for Estimating Magnitude and Frequency of Floods in Minnesota (Reference 3).

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Figure 2. Flooding in the spring of 1978 overtopped State Highway 89 on the west side of city. View is looking west.

Figure 3. City ice skating rink inundated by 1978 spring flooding. Rink is located north of Beltrami Street.

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Figure 4. Shallow flooding in residential area on east side of County Road 54 just north of State Highway 89 intersection during spring 1978.

Figure 5. Shallow flooding in business area on east side of County Highway 54 just south of State Highway 89 intersection during spring 1978.

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Discharges for the 500-year event were interpolated from a graph of the 10-year, 50-year and 100-year events. The results of the analysis were coordinated with the Minnesota Department of Natural Resources, the Corps of Engineers, the United States Geological Survey and the Soil Conservation Service.

Peak discharges for the 10-,50-, 100-, and 500-year floods on the Mud River are shown in Table 1.

TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQUARE MILES)	PEAK DISCHARGES (CFS) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
Mud River At Grygla	116	1410	2360	2840	4200

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of the flooding sources studied in detail in Grygla were carried out to provide estimates of the elevations of floods of the selected recurrence intervals along the flooding source studied in detail.

Locations of selected cross sections used in the hydraulic analyses are shown on the flood profiles. For stream segments for which a floodway was computed, selected cross section locations are also shown on the Flood Boundary and Floodway Map.

Water-surface elevations for the Mud River for floods of the selected recurrence intervals were computed through the use of the COE's HEC-2 step-backwater computer program (Reference 4). Starting water-surface elevations for the Mud River were developed using the slope-area method. Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals.

Effective flow areas of the flood plain cross sections and channel and over-bank roughness coefficients (Manning's "n") were selected for each cross section using field inspection data and engineering judgment. Roughness values are 0.030 for the main channel and from 0.035 to 0.080 for the overbanks of the Mud River.

Although flood elevations on the Mud River can be raised by debris accumulations and ice jams at hydraulic structures, the incidence of ice induced flooding is highly erratic and, based on random weather fluctuations, is not subject to statistical prediction. The hydraulic analyses for this study are based only on the effects of unobstructed flow. The flood elevations as shown on the profiles are therefore, considered valid only if the hydraulic structures in general remain unobstructed, and if channel and overbank conditions remain essentially the same as ascertained during the study. Changes in existing bridge dimensions and elevations could also affect the given water-surface elevations.

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All elevations are referenced from National Geodetic Vertical Datum of 1929 (NGVD); elevation reference marks located within Grygla are shown on the FIRM and FBFM mapping.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages state and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study includes a flood boundary map designed to assist communities in developing sound flood plain management measures.

4.1 Flood Boundaries

In order to provide a national standard without regional discrimination, the 100-year flood has been adopted by the Federal Emergency Management Agency as the base flood for purposes of flood plain management measures. The 500-year flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the boundaries of the 100-year and the 500-year floods have been delineated using the elevations determined at each cross section; between cross sections the boundaries were interpolated using topographic maps photo-enlarged to a scale of 1:6000, with a contour interval of five feet (Reference 5).

The boundaries of the 100-year and 500-year floods are shown on the Flood Boundary and Floodway Map. Small areas within the flood boundaries may lie above the flood elevations, and therefore would not be subject to flooding; owing to lack of detailed topographic information or to limitations of the map scale, such areas are not shown. In cases where the 100-year and the 500-year flood boundaries are close together only the 100-year boundary has been shown.

4.2 Floodways

Encroachment on flood plains, such as artificial fill, reduces the flood-carrying capacity, increases flood heights of streams, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, the concept of a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood is divided into a floodway and floodway fringe. The floodway is the channel of a stream, plus any adjacent flood plain areas, that must be kept free of encroachment in order that the 100-year flood be carried without substantial increases in flood heights. Minimum standards of the Federal Emergency Management Agency limit such increases in flood heights to 1.0 foot, provided that hazardous velocities are not produced. In Minnesota, however, flood plain encroachment is limited by Minnesota Regulations to that which would cause a 0.5-foot increase in flood heights above pre-floodway conditions at any point (Reference 6). Floodways having no more than a 0.5-foot surcharge were delineated for this study.

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The floodway presented in this study has been computed with regard to existing and proposed development and has been coordinated with the City of Grygla and the Minnesota Department of Natural Resources. The results of these computations were tabulated at selected cross sections for each stream segment for which a floodway was computed (Table 2). Portions of the floodway lie outside the corporate limits.

As shown on the Flood Boundary and Floodway Map, the floodway boundaries were determined at cross sections; between cross sections, the boundaries were interpolated. In cases where the boundaries of the floodway and the 100-year flood are either close together or collinear only the floodway boundary has been shown. Portions of the floodway of the Mud River lie outside of the corporate limits.

The area between the floodway and the boundary of the 100-year flood is termed the floodway fringe. The floodway fringe thus encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood more than 0.5 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 6.

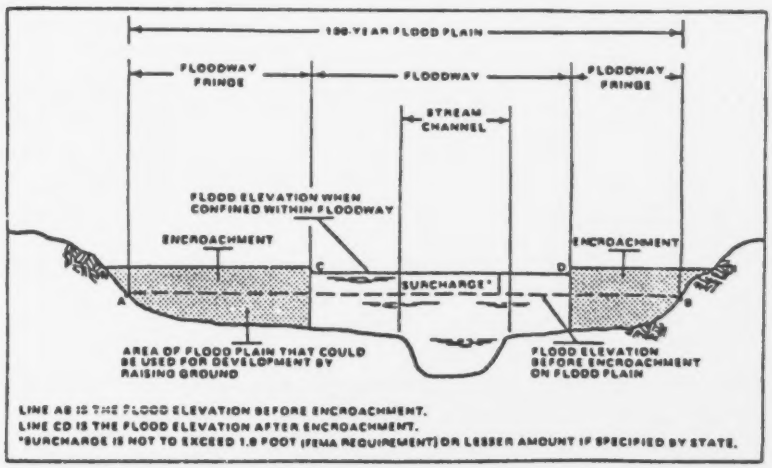
100-YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE*
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE AB IS THE FLOOD ELEVATION BEFORE ENCROACHMENT.
LINE CD IS THE FLOOD ELEVATION AFTER ENCROACHMENT.
*SURCHARGE IS NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE.

FIGURE 6 - Floodway Schematic

The floodways in this report are recommended to local agencies as minimum standards that can be adopted or that can be used as a basis for additional studies.

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE [1]	WIDTH [2] (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY	INCREASE (FEET)
MUD RIVER								
A	690	835/0	2180	1.3	1174.3	1174.3	1174.8	0.5
B	2460	260/110	700	4.1	1175.1	1175.1	1175.5	0.4

[1] FEET ABOVE LIMIT OF DETAIL STUDY 3250

[2] TOTAL WIDTH/WIDTH WITHIN CORPORATE LIMITS

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF GRYGLA, MN.
(MARSHALL COUNTY)

FLOODWAY DATA

MUD RIVER

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5.0 INSURANCE APPLICATION

In order to establish actuarial insurance rates, the Federal Emergency Management Agency has developed a process to transform the data from the engineering study into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors (FHF), and flood insurance zone designations for each flooding source affecting the City of Grygla.

5.1 Reach Determinations

Reaches are defined as lenghts of watercourses having relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference does not have a variation greater than that indicated in the following table for more than 20 percent of the reach.

Average Difference Between 10- and 100-Year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

The locations of the reaches determined for Grygla are shown on the Flood Profiles and are summarized in the Flood Insurance Zone Data Table (Table 3).

5.2 Flood Hazard Factors

The Flood Hazard Factor (FHF) is used to correlate flood information with insurance rate tables. Correlations between property damage from floods and their Flood Hazard Factors are used to set actuarial insurance premium rate tables based on Flood Hazard Factors from 005 to 200.

The Flood Hazard Factor for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations expressed to the nearest one-half foot, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7, the Flood Hazard Factor is 005; if the difference is 1.4 feet, the Flood Hazard Factor is 015; if the difference is 5.0 feet, the Flood Hazard Factor is 050. When the difference between the 10- and 100-year water-surface elevations is greater than 10 feet, accuracy for the Flood Hazard Factor is to the nearest foot.

5.3 Flood Insurance Zones

After the determination of reaches and their respective Flood Hazard Factors, the entire incorporated area in Grygla was divided into zones, each having a specific flood potential or hazard. Each zone was assigned one of the following flood insurance zone designations:

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Zone A3: Special Flood Hazard Areas inundated by the 100-year flood, determined by detailed methods; base flood elevations shown, and zones subdivided according to Flood Hazard Factor.

Zone B: Areas between the Special Flood Hazard Area and the limits of the 500-year flood, including areas of the 500-year flood plain that are protected from the 100-year flood by dike, levee, or other water control structure; or areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.

Zone C: Areas of minimal flooding.

Table 3, "Flood Insurance Zone Data", summarizes the flood elevation differences, Flood Hazard Factors, flood insurance zones, and base flood elevations for each flooding source studied in detail in the community.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for Grygla is, for insurance purposes, the principal result of the Flood Insurance Study. This map (published separately), contains the official delineation of flood insurance zones and base flood elevation lines. Base flood elevation lines show the locations of the expected whole-foot-water-surface elevations of the base (100-year) flood. This map is developed in accordance with the latest flood insurance map preparation guidelines published by the Federal Emergency Management Agency.

6.0 OTHER STUDIES

The Federal Insurance Administration has published a Flood Hazard Boundary Map for Grygla (Reference 7). Any differences between the Flood Hazard Boundary Map and this study are justified due to the more detailed nature of the Flood Insurance Study.

This report either supersedes or is compatible with all previous studies published on streams studied in this report and should be considered authoritative for the purposes of the National Flood Insurance Program.

7.0 LOCATION OF DATA

Survey, hydrologic, hydraulic and other pertinent data used in this study can be obtained by contacting the office of the Federal Emergency Management Agency, Regional Director, 300 South Wacker Drive, 24th Floor, Chicago, Illinois 60606.

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FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1% (100-YEAR) FLOOD AND			FLOOD HAZARD FACTOR	ZONE	BASE FLOOD ELEVATION (FEET NGVD)[3]
		10% (10-YEAR)	2% (50-YEAR)	0.2% (500-YEAR)			
MUD RIVER							
Reach 1	0001	-1.6	-0.3	-0.7	015	A3	Varies - See Map

[1] FLOOD INSURANCE RATE MAP PANEL [2] WEIGHTED AVERAGE [3] ROUNDED TO NEAREST FOOT

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF GRYGLA, MN.
(MARSHALL COUNTY)

FLOOD INSURANCE ZONE DATA

MUD RIVER

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8.0 REFERENCES AND BIBLIOGRAPHY

1. U.S. Department of Commerce, Census Bureau, Census of Population, General Population Characteristics, 1970.

2. U.S. Department of Commerce, National Oceanic and Atmospheric Administration Environmental Data Services, Climatological Data for Minnesota, Asheville, North Carolina, January 1975.

3. U.S. Geological Survey, Water Resources Division, Techniques for Estimating Magnitude and Frequency of Floods in Minnesota, Lowell C. Guetzkow, May 1977.

4. U.S. Army Corps of Engineers, Hydrologic Engineering Center, Computer Program 723-X6-L202A, HEC-2 Water Surface Profiles, August 1979.

5. U.S. Geological Survey, 7.5 Minute Series Topographic Maps, Scale 1:24000, Contour Interval 5 feet:

Carmel, Minnesota	1973
Fourtown, Minnesota	1973
Fourtown NW, Minnesota	1973
Gates Corner, Minnesota	1973
Grygla, Minnesota	1973
Grygla NE, Minnesota	1973
Grygla SW, Minnesota	1973

6. Minnesota Department of Natural Resources, Division of Waters, Technical Report No. 6, The Regulatory Floodway in Floodplain Management, September 1977.

7. U.S. Department of Housing and Urban Development, Flood Insurance Administration, Flood Hazard Boundary Map, City of Grygla, Minnesota, August 8, 1975.

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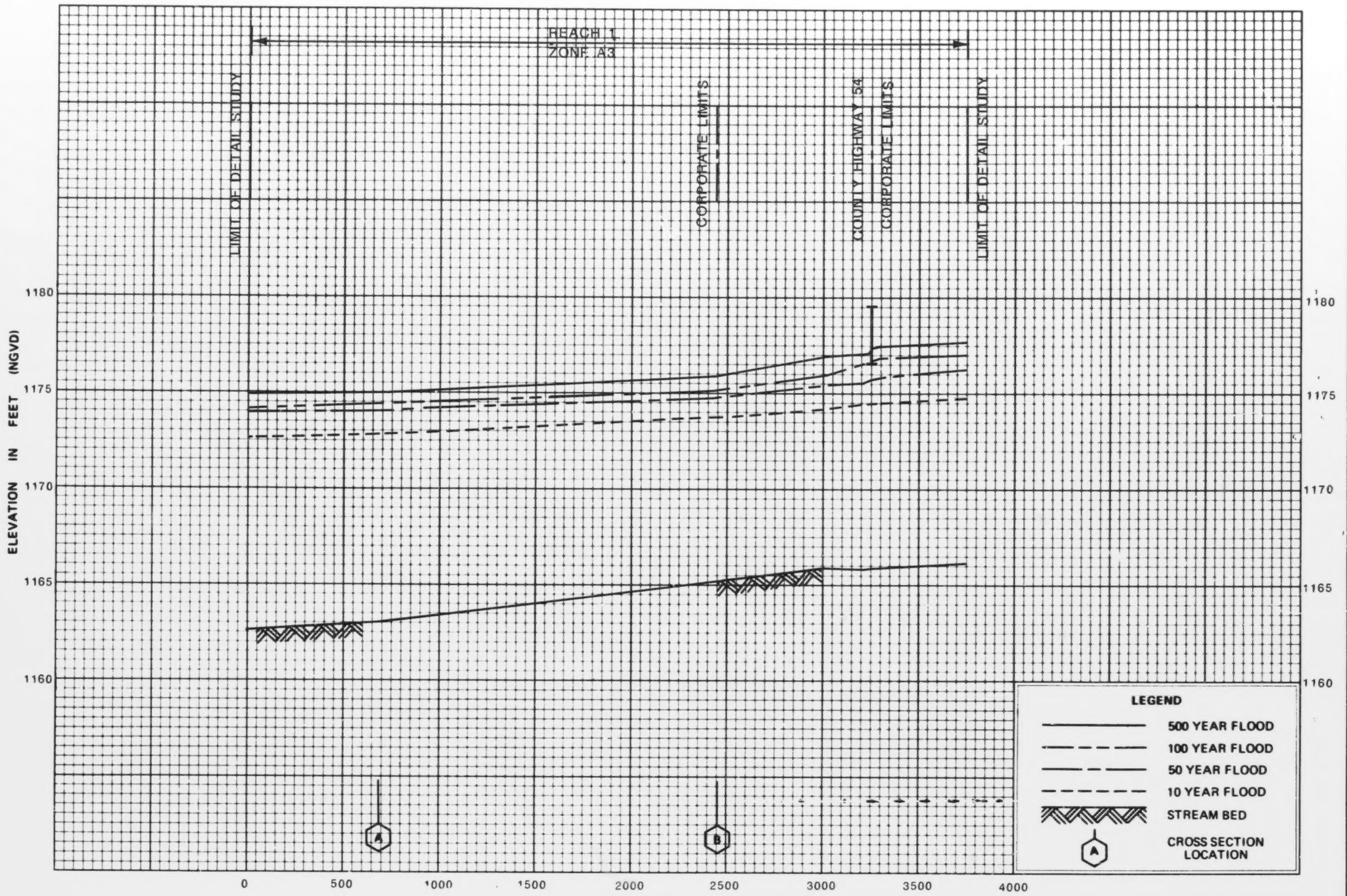

FLOOD PROFILES

MUD RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF GRYGLA, MN.
(MARSHALL COUNTY)

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